Received December 5, 1771.

XLVI. Kepler's *Method of computing the Moon's Parallaxes in Solar Eclipſes, demonſtrated and extended to all Degrees of the Moon's Latitude, as alſo to the aſſigning the Moon's correſpondent apparent Diameter, together with a conciſe Application of this Form of Calculation to thoſe Eclipſes; by the late* H. Pemberton, *M.D. F.R.S. Communicated by* Matthew Raper, *Eſq; F.R.S.*

Read Dec. 5, 1771.

THE calculation of ſolar eclipſes having been generally reputed a very operoſe proceſs, from the repeated computations required of the moon's parallaxes by their continually varying during the progreſs of the eclipſe, I was once induced to conſider Kepler's compendium for performing this, delivered in his Rudolphine tables, of which he had given a demonſtration in his treatiſe entitled *Aſtronomiæ pars optica.* But this demonſtration is perplext, and the method itſelf wants correction, to render it perfect. Both theſe defects I endeavoured to ſupply by the following propoſitions, by by which may be determined with ſufficient exactneſs the moon's apparent latitude, not only in eclipſes, but in all diſtances of the moon from the ecliptic.

But to theſe propoſitions I ſhall here premiſe the method I have generally uſed for computing the nonageſime degree, and its diſtance from the zenith; this form of calculation not being encumbered with any diverſity from the difference of caſes.

LEMMA.

To find the nonageſime, or 90th degree of the ecliptic from the horizon, and its diſtance from the zenith, the latitude of the place, and the point of the equinoctial on the meridian being given.

In Tab. XV. Fig. 1. 2. 3. 4. let A B be the equinoctial, A C the ecliptic, D the zenith, D E the meridian, and D F perpendicular to the ecliptic, whereby F is the nonageſime degree, and DF the diſtance of that point from the zenith. Then from D E, the latitude of the place, and A E the diſtance of the meridian from Aries, the arch of the ecliptic A F, and the perpendicular D F may be thus found.

Let I be the pole of the equinoctial, and H the pole of the ecliptic. Then A E augmented by 90° is the meaſure of the angle D I H, or of its complement to four right angles: And the ſquare of the radius is to the rectangle under the ſines D I, I H, as the ſquare of the ſine of half the angle D I H, or of half its complement to four right angles, to the rectangle under the radius, and half the exceſs of the coſine of the difference between D I and I H, above the coſine of D H, or the ſine of D F.

Philoſ. Tranſ. Vol. LXI. TAB. XV. p. 438.

Fig. 1.

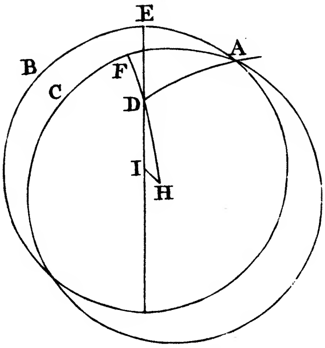


Fig. 2.

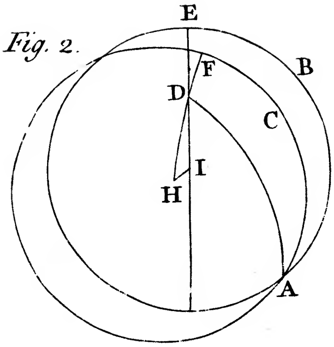


Fig. 3.

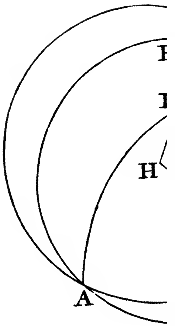


Fig. 5.

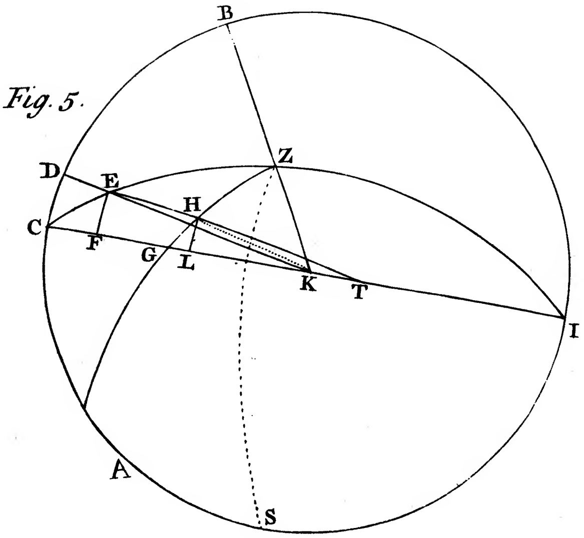
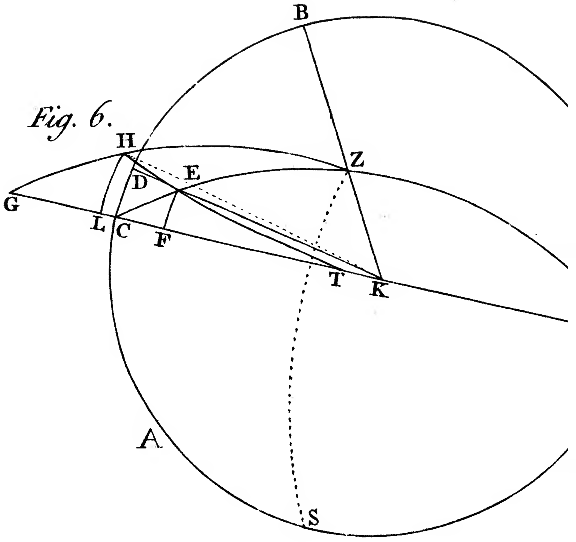


Fig. 6.



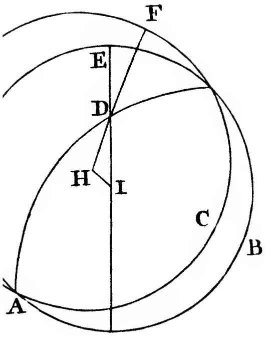


Fig. 4.

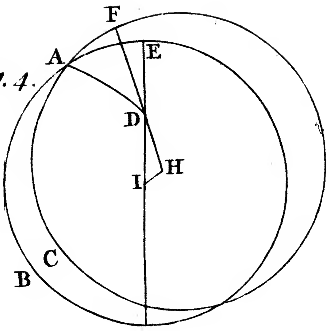
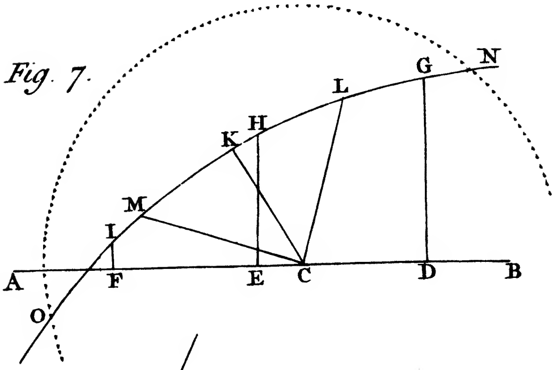


Fig 7.



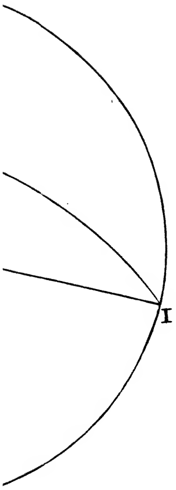
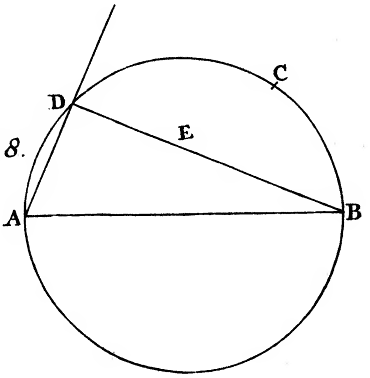


Fig. 8.



In the next place, the arch A D being drawn, in the rectangular triangle AED, the radius is to the coſine of D E, as the coſine of A E to the coſine of AD; and in the rectangular triangle A F D, the coſine of D F is to the radius, as the coſine of AD to the coſine of AF; therefore, by equality, the coſine of D F is to the coſine of D E as the coſine of A E to the coſine of AF [*a*], the arch A F counted according to the order of the ſigns being to be taken ſimilar in ſpecies to A E: For when AE is leſs than a quadrant (as in fig. 1.), AF will be leſs than a quadrant; and when AE ſhall be greater than 1, 2, or 3 quadrants, AF counted according to the order of the ſigns, ſhall exceed the ſame number of quadrants. For, ſince D E and D F are each leſs than quadrants, when A E in the triangle DEA is alſo leſs than a quadrant, the hypothenuſe A D is leſs than a quadrant, when in the triangle D F A the legs D F and F A are ſimilar, that is, F A will be leſs than a quadrant; (as in fig. 1.) but if AE is greater than a quadrant; (as in fig. 2.) that is, diſſimilar to DE, the hypothenuſe DA will be greater than a quadrant, and the arches DF, FA likewiſe diſſimilar, and AF greater than a quadrant; alſo in fig. 3 and 4, the arches AE, AF counted from A, in conſequence, will be the complements to a circle of the arches AE, AF in the triangles A DE, A D F.

For an example, let the caſe be taken in Dr. Halley's aſtronomical tables, where an occultation of the moon with a fixed ſtar is propoſed to be computed, the lati-

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[*a*] The ſame may be concluded from the ſ. HD being to ſ. T D as ſ. HID to ſ. IHD.

tude

tude of the place being 65°. 50′. 50″, and the point of the equinoctial culminating 25°. 36′. 24″, from the firſt point of Aries.

This caſe relates to fig. 1. and the computation will ſtand thus,

For the diſtance of the nonageſime degree from the zenith,

	° ′ ″	
Diſtance of E in conſequnce from A, the equinoctial point	25.36.24	
Add	90. 0. 0	
Gives the angle HID	115.36.24	L. Sines
Half HID	57.48.12	9.92749 9.92749
HI, the obliquity of the ecliptic uſed by Dr. Halley	23.29. 0	9.60041
ID, the complement of the latitude	24. 9.10	0.61190
Natural number correſponding	0.11676	9.06729
Its double, to be deducted from	0.23352	Sum, thrice
the nat. coſine of ID∽IH (0°.40′.10″.)	0.99993	rad. deducted
leaves the nat. coſine of HD (39. 58. 0.)	0.76641	
Therefore DF is 50. 2. 0.		
For the arch AF		
Coſine of DF, or ſine of HD (co. arith.)		0.19223
Coſine of the latitude, or ſine of ID		9.61191
Coſine of AE		9.95510
Coſine of the long. of the 90th deg. (54°.56′.24″.)		9.75924

The arch HD might have been computed by the verſed ſine of the angle HID. But I chuſe the method above; very few logarithmic tables having the logarithmic verſed ſines. Sir J. Moore, and Sherwin have given indeed ſuch tables, but they are imperfect, extending only to a quadrant.

Moreover, if a table of natural ſines is not at hand, the arch AD may be found logarithmically thus [a].

Take half the ſum of the four firſt logarithms in the preceding computation of HD, *viz.* 19.53364

Deduct the ſine of half DI ∽ IH 7.76675

the remainder 11.76689

This remainder ſought in the table of logarithmic tangents gives the correſpondent ſine 9.99994

This ſine deducted from the firſt number leaves the ſine of half HD, that is, 19°. 59′. 0″. 9.53370

PROPOSITION I.

In fig. 5, 6. Let BCA be the ecliptic, E the moon appearing in the ecliptic in C, from the place of the earth whoſe zenith is Z; B the nonageſime degree, the arch ZB being perpendicular to the ecliptic, ZEC the circle of altitude; ED the moon's latitude, the arch DE being perpendicular to the ecliptic CB; and DC the parallax in longitude: then DE is to the horizontal parallax, as the ſine of ZB, the diſtance of the nonageſime degree from the zenith, or the altitude of the pole of the ecliptic, to the radius; alſo DC is to the moon's horizontal parallax as ſ. BC x coſ. ZB to the ſquare of the radius.

The arch CE is to the moon's horizontal parallax as ſ. ZC to radius, and DE is to CE as ſ. ZB to ſ. ZC; whence by equality DE is to the horizontal parallax as ſ. ZB to the radius.

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[a] See Philoſophical Tranſactions, Vol. LI. P. II. p. 927, 928.

Again, ſ. ZB is to radius as the tangent of ZB to the ſecant of ZB; therefore DE is to the horizontal parallax, as t. of ZB to ſec. ZB: but DC is to DE as ſ. BC to t. ZB; whence by equality DC is to the horizontal parallax as ſ. BC to the ſec. ZB, or as ſ. BC × coſ. ZB to the ſquare of the radius.

COROLLARY.

If the point S be taken 90 degrees from the apparent place of the moon, and the arch SZ be drawn, in the ſpherical triangle SBZ, the cſ. ZB × cſ. BCS, that is, cſ. ZB × ſ. BC is equal to rad. × cſ. ZS: therefore DC is to the horizontal parallax as cſ. ZS, or the ſine of the diſtance of S from the horizon to the radius. And if the point S is taken in conſequence of the moon, it will be above the horizon, when the nonageſime degree is alſo in conſequence of the moon; otherwiſe below.

PROPOSITION II.

Let G be the apparent place of the moon out of the ecliptic in the circle of latitude CK, K being the pole of the ecliptic, and H her true place. Then EF, the diſtance of the moon from the circle of her apparent latitude, when ſhe is ſeen in the ecliptic, is equal to HL, her diſtance from the circle of her apparent latitude, when her apparent place is G.

If a great circle EHT be drawn through E and H, till it meet the circle of the apparent latitude in T, the four great circles CZ, GZ, CT, ET, interſecting each other, the ratio of ſ. ZC to ſ. CE is compounded of the ratio of ſ. ZG to ſ. GH and of the ratio of ſ. SHT to ſ. ET [a]. But CE and GH being the parallaxes in altitude at the reſpective diſtances from the zenith ZC, ZG, ſ. ZC is to ſ. CE as ſ. ZG to ſ. GH: therefore the ſine of HT will be equal to the ſine of ET, and the arches HT, ET together make a ſemicircle: whence ET is equal to HL.

COROLLARY.

The arch KH being drawn, the parallax in longitude, when the moon is in H, will be to HL as rad. to ſ. KH, or the coſine of the latitude; and EF, or its equal HL, to CD as ſ. KE to the radius. Therefore the moon's parallax in longitude, when in H, is to the parallax in longitude, when ſhe appears in the ecliptic, as the ſine of KE to the ſine of KH, that is, as the coſine of the latitude, when the moon appears in the ecliptic, to the coſine of her latitude in H.

PROPOSITION III.

When the moon appears out of the ecliptic, if her latitude is ſmall, the difference of the moon's latitude, when the moon appears in the ecliptic under the ſame apparent longitude, if both latitudes are on the ſame ſide of the ecliptic, otherwiſe their ſum, will be to the moon's apparent latitude, nearly as the ſine of the moon's diſtance from the zenith, when appearing in the ecliptic under the ſame apparent longitude, to the ſine of the correſponding apparent diſtance.

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[a] Ptolem. Almag. L. i. c. 12. Menel. Spheric. L. iii. pr. 1.

Fig. 6. When the moon appears out of the ecliptic in G, the four great circles CZ, GZ, CT, ET, interſecting each other as before, the ratio of ſ. CZ to ſ. ZE will be compounded of the ratio of ſ. CG to ſ. EH, or of CG to EH in theſe ſmall arches, and of the ratio of ſ. HT to ſ. GT, which laſt ratio, when the latitude is ſmall, and HT near a quadrant, is nearly the ratio of equality. Now in the triangle EKH the arch EH exceeds the difference of KE and KH, that is, the difference of the latitudes, when both the latitudes are on the ſame ſide of the ecliptic, and their ſum, when the latitudes are on the oppoſite ſides. But here the exceſs will be inconſiderable. Therefore if an arch X be taken, whoſe ſine ſhall be to the ſine of the difference, or ſum of the latitudes, as ſ. ZC to ſ. ZE, X ſhall be nearly equal to CG, the apparent latitude in G.

COROLLARIES.

1. If the arches DE, BZ be continued to K, the pole of the ecliptic, the four great circles CB, CZ, DK, BK, will interſect each other, and ſ. BD will be to the ſine of BC in the ratio compounded of the ratio of ſ. ZE to ſ. ZC, and of ſ. DK to ſ. EK, the leaſt of which ratios, the arch DE being ſmall, and DK a quadrant, is nearly the ratio of equality: therefore ſ. BD is to ſ. BC nearly as ſ. ZE to ſ. ZC; ſo that ſ. BD will be to ſ. BC nearly as the difference of the moon's true latitude, when ſhe appears in G from her latitude DE, wherewith ſhe would appear

in the ecliptic, if the points H and E are both on the ſame ſide of the ecliptic, or as the ſum of thoſe latitudes, when H and E are on different ſides of the ecliptic, to the moon's viſible latitude.

2. The moon's apparent diameter, is to her horizontal diameter, as the ſine of her apparent diſtance from the zenith to the ſine of her true diſtance. Therefore, when the moon is in C, her apparent diameter is to her horizontal diameter as ſ. ZC to ſ ZE, and ſ. ZC being to ſ. ZE nearly as ſ. BC to ſ BD; the moon's apparent diameter in C will be to her horizontal diameter nearly as ſ. BC to ſ. BD.

Again, the ratio of ſ. CG to ſ. EH is compounded of the ratio of ſ. ZG to ſ. ZH, and of the ratio of ſ. CT to ſ. ET; and is alſo compounded of the ratio of ſ. ZC to ſ. ZE, and of the ratio of ſ. GT to ſ. TH; but the ſine of ET is equal to the ſine of TH, the arches ET and TH compoſing a ſemi-circle; alſo the ſine of CT there differs little from the ſine of GT; therefore ſ. ZG is to ſ. ZH, that is, the moon's apparent diameter, when in G, to her horizontal diameter, nearly as ſ. ZC to ſ. ZE, or nearly as ſ. BC to ſ. BD.

3. In all latitudes of the moon, EH will not greatly exceed the difference, or ſum of the moon's latitude in H, and the latitude wherewith ſhe would appear in the ecliptic. Therefore the ratio of ſ. ZC to ſ. ZE being compounded of the ratio of ſ. CG to s. EH, and of the ratio of ſ. HT to ſ. GT, if X be taken, that its ſine be to the ſine of the difference or ſum of the latitudes, as ſ. ZC to ZE, ſ. X will be nearly to ſ. CG as ſ. HT to ſ. GT. Hence the difference of ſ. X and ſ. GC will be to ſ. CG nearly as the difference

ence of ſ. HT and ſ. GT to ſ. GT, HT not ſenſibly differing from TL. Now FT and TL together make a ſemi-circle, and the ſum of FG and GL is twice the difference of TL from a quadrant, and the difference between FG and GL equal to twice the difference of TG from a quadrant, alſo the difference between the ſines of TL and TG is equal to the difference of the verſed ſines of the differences of thoſe arches from quadrants; and moreover the rectangle under the ſines of two arches is equal to the rectangle under half the radius, and the difference of the verſed ſines of the ſum and difference of thoſe arches: therefore the difference of the ſines of X and of CG will be to the ſine of CG as the rectangle under the ſine of half FG and the ſine of half GL to the rectangle under half the radius and the ſine of GT, and in theſe ſmall arches the difference of X and CG will be to CG nearly as the rectangle under the ſines of FG and GL to the rectangle under twice the radius and the ſine of GT, or even twice the ſquare of the radius, this difference being to be added to X, when the moon's apparent latitude, and that by which ſhe would appear in the ecliptic, are on the ſame ſide of the ecliptic, otherwiſe deducted from X for the final correction of the apparent latitude. And in the laſt place this correction will be always ſo ſmall in quantity, that in computing it CF may be ſafely ſubſtituted for GL.

4. Moreover, the exceſs of the moon's apparent diameter, when ſeen in G, above her apparent diameter in C, bears a leſs proportion to her horizontal diameter than the rectangle under the ſine of her horizontal

horizontal parallax, and twice the ſine of half the apparent latitude CG to the ſquare of the radius.

The ſine of CE is to the ſine of ZC as the ſine of the horizontal parallax to the radius; and CE, the difference of ZC and ZE, being very ſmall, the difference of the ſines of thoſe arches may be eſteemed to bear to the ſine of CE, the ratio of the coſine of ZC to the radius; and thus the difference of the ſines of ZC and ZE, will be to the ſine of ZC as the rectangle under the ſine of the horizontal parallax and the coſine of ZC to the ſquare of the radius. And in like manner the difference of the ſines of ZG and ZH, will be to the ſine of ZG, as the rectangle under the ſine of the horizontal parallax and the coſine of ZG to the ſquare of the radius. But ſ. ZE is to ſ. ZC as the moon's horizontal diameter to her apparent diameter in C, and ſ. ZH to ſ. ZG as the moon's horizontal diameter to her apparent diameter in G. Therefore the difference of the apparent diameter in G from the apparent diameter in C, is to the horizontal diameter, as the rectangle under the ſine of the horizontal parallax, and the difference of the coſines of ZC and ZG, to the ſquare of the radius. But in the triangle CZG, the difference of ZC and ZG is leſs than the third ſide CG: therefore the chord of the difference of thoſe arches, and much more the difference of their coſines, will be leſs than the chord of CG, or twice the ſine of half CG. Hence the ratio of the augmentation of the apparent diameter in G to the apparent diameter in C, will be leſs than the rectangle under the ſine of the horizontal parallax and twice the ſine of half CG, the apparent latitude, to the ſquare of the radius.

More accurately, the chord of the difference of ZC and ZG being to the difference of their coſines, as the radius to the coſine of half their ſum, the difference of the moon's apparent diameters in C and G may be conſidered as nearly bearing to the horizontal diameter, the ratio of the parallelopipedon, whoſe altitude is the ſine of the horizontal parallax, and baſe the rectangle under the chord of CG and the coſine of ZC, to the cube of the radius; the coſine of ZC being to the coſine of ZB, the diſtance of the nonageſime degree from the zenith, as the coſine of BC, the apparent diſtance of the moon from the nonageſime degree to the radius. But this difference can never be any ſenſible quantity.

5. When the moon is in the longitude of the nonageſime degree, the parallax in longitude ceaſes, and the apparent latitude is the difference of the moon's apparent diſtance from the zenith, and the diſtance of the nonageſime degree from the ſame.

But now ſince DC is to the horizontal parallax as the rectangle under the ſine of BC, and the coſine of ZB to the ſquare of the radius; if an arch be taken to the horizontal parallax as ſ. BD × cſ. ZB to the ſquare of the radius, this arch will differ but little from the parallax in longitude, and is uſed by Kepler as ſuch; however, it ought to be corrected by adding it to BD, and taking an arch to this in the proportion of the ſine of BD thus augmented to the ſine ſimply of BD; and this laſt arch will be equal to the parallax in longitude without ſenſible error.

Again, DE taken to the horizontal parallax as the ſine of ZB to the radius, is conſidered by Kepler as the

the moon's parallax of latitude in eclipſes; but this being deducted or added as the caſe requires gives EH, which being augmented in the proportion of the ſine of BD+DC to the ſine of BD, gives truly the apparent latitude without ſenſible error, when the latitude is ſmall: But, when greater, requires to be corrected by adding together the logarithmic ſine of the latitude now found, the ſine of EH and the logarithm of DE, the ſum of which is the double of the correction required.

In the laſt place the moon's horizontal diameter augmented in the proportion of the ſine of BC to the ſine of BD exhibits the moon's apaprent diameter.

And here the calculation will proceed thus:

In the example above choſen for computing the nonageſime degree,

The moon's longitude is given from ♈	62°. 2.′38″	
The longitude of the nonageſime degree was found above to be	54°.56′.24″	
Therefore BD=	7. 6. 14	
its ſine		9.09226
BZ, as found above, 50°.2′.0″. its coſine		9.80777
The horizontal parallax in ſeconds		3.52387
	° ′ ″	
	4.25	2.42390
This added to BD gives	7.10.39	
Its ſine		9.09673
Diff. from the firſt ſine		447
This added to the log. of 4′. 25″, gives the log. of 4′. 28″, for the moon's parallax in longitude, ſuch as is derived from the parallax in altitude by the parallactic angle,		2.42837

Again,		
The ſine of ZB. 50°. 2′. 0″.		9.88447
Horizontal parallax 55′.41″.=3341 ſeconds		3.52387
Their ſum, rejecting the radius, gives DE=42′.40″		3.40834 A
The moon's latitude 4°. 50′.18″		
Their ſum, (EH) the lat. being ſouth, 5°. 32′.58″		
Its ſine		8.98546 B
From the preceding calculation		447
For the apparent latitude, were the moon's lat. ſmall	5°. 6′.25½″	8.98993C
But the moon's latitude being here great, the numbers markt A, B, C, being added together, give twice the correction.	0°. 0′.24″	1.38373
Its half	0°. 0′.12″	
This deducted from N° C, the moon's latitude being ſouth, gives for the apparent lat.	5°.36′.13½″	
Laſtly,		
From the moon's horizontal parallax her horizontal diameter is	0°.30′.37½″ or 1837½″	3.26423
The number from the firſt calculation		447
The moon's apparent diameter 1856½″ or 30′.56½″		3.26870

NOW in ſolar eclipſes the moſt regular method of treating them would be to conſider the viſible way of the moon from the ſun, as a line of continued curvature, which it really is; and as it differs not greatly from a ſtreight line, an arch of a circle may ſafely be uſed for it. But to form a computation in the ſphere upon this principle would require a proceſs ſomewhat intricate; but all the particulars uſually inquired into in ſolar eclipſes may readily be aſſigned graphically with ſcale and compaſs after this manner.

Firſt, find the time nearly of the conjunction of the luminaries, without being ſolicitous to inveſtigate the time with exactneſs. To this point of time aſſign in ſome crude manner the moon's parallax in longitude, by which a time may eaſily be aſſumed, not very diſtant from the viſible conjunction. This may very commodiouſly be performed inſtrumentally by the propoſition, with which I ſhall conclude this paper. To this point of time compute the place of the ſun and moon, alſo for an hour before and after, or rather for ſuch an interval of time as may include the whole eclipſe, and not too much exceed, of which an eſtimate may eaſily be made by the forementioned propoſition here ſubjoined. But all theſe places of the luminaries may be deduced from the calculation for finding the true conjunction, by means of the horary motions. In the next place, to each of theſe points of time compute the diſtance from the zenith and the place in the ecliptic of the nonageſime degree. Then from each poſition of the nonageſime degree, compute by the method deſcribed, the moon's parallax in longitude, her apparent latitude, and apparent diameter.

Fig. 7. After this, aſſuming upon any ſtraight line, as AB, the point C for the ſun, from thence lay down for the three points of the ecliptic, for which the preceding computations were made, the three diſtances CD, CE, CF, which ſhall be the meaſures in ſeconds, taken from a ſcale of equal parts ſufficiently large, of the diſtances of the moon from the ſun in each, compounded with their reſpective parallaxes in longitude, ſo as to repreſent the reſpective apparent diſtances of the moon from the ſun in longitude. Upon theſe points erect the perpendiculars DG, EH, FI, for the moon's correſpondent apparent latitudes, and deſcribe through theſe three points the arch of a circle, as repreſenting the viſible way of the moon from the ſun during the eclipſe.

Then

Then if from C the line CK be drawn from the centre of this circle, K will be the place of the moon at the greateſt obſcuration. The beſt method for aſſigning this point K is to deſcribe the arch of a circle to the center C with any interval, whereby it may cut the arch GHI, as in N and O; for the point K biſects the intercepted arch NKO. Again, if CL, CM be applied from C to the arch IHG, each equal to the ſum of the ſemidiameter of the ſun, and apparent ſemidiameter of the moon, L will be the place of the moon's center at the beginning, and M the ſame at the end of the eclipſe.

In the laſt place, for finding the time, when the moon ſhall be in each of the points L, K, M, meaſure the chords of the arches HG, HL, HM, HI, as not ſenſibly differing from the arches themſelves. Then A denoting HL or HM, and B the ſum of GH and HI, the time ſought for the greater chord may be conſidered equal to $\overline{\frac{A}{\frac{1}{2}B}-\overline{\frac{A}{\frac{1}{2}B}}\Big|^{q}\times\frac{GH\backsim HI}{B}}\Big|$ × the time of the moon's paſſing from G to H, or from H to I. The time for the leſſer chord will be $\overline{\frac{A}{\frac{1}{2}B}\times\overline{\frac{A}{\frac{1}{2}B}}\Big|^{q}\times\frac{GH\backsim HI}{B}}\Big|$ × the time above named; and in the laſt place, the time of the moon's paſſage between H and K equal to $\overline{\frac{HK}{\frac{1}{2}B}+\overline{\frac{HK}{\frac{1}{2}B}}\Big|^{q}\times\frac{GH\backsim HI}{B}}\Big|$ × the time ſpecified.

This calculation I deduced from Sir Iſaac Newton's Differential Method; and in the laſt caſe — or $+\overline{\frac{HK}{\frac{1}{2}B}}\Big|^{q}$ ×, &c. is to be taken, as K ſhall fall within the greater or leſſer of the arches GH, HI: but foi the moſt part the term may be wholly omitted.

If this method be applied to the occultation of a ſtar, the diſtances CD, CE, CF muſt be the parallaxes in longitude computed according to the firſt of the preceding propoſitions united with the reſpective diſtances of the moon from the ſtar in longitude, contracted in the proportion of the coſines of the moon's latitudes, or at leaſt of the ſtar's latitude to the radius. Alſo the moon's apparent latitudes muſt, for the moſt part, be corrected by the third corollary of the third propoſition, and the apparent diameters, if the correction could amount to any ſenſible quantity, by the 4th corollary.

THE propoſition, I made mention of above for eſtimating the diſtance of the true conjunction from the viſible, is this. Fig. 8. In any circle, whoſe diameter is AB, let the arch AC meaſure twice the complement of the declination of any point in the ecliptic CD; in like manner meaſure twice the complement of the latitude, and AD, BD being drawn, let DE be the verſed ſine of the diſtance in right aſcenſion, of that point of the ecliptic from the meridian taken to a radius equal to the perpendicular let fall from C upon the chord AD; then BE will be the ſine of the diſtance of the point aſſumed in the ecliptic from the horizon, to a radius equal to the diameter of the circle.

Therefore, if the diameter of the circle be the meaſure, upon any ſcale of equal parts, of the moon's horizontal parallax, and the point taken in the ecliptic be 90° diſtant from the moon's apparent longitude; the right aſcenſion and declination of this point being firſt taken from tables of right aſcenſion and declination,

nation, BE, found as above, will be the meaſure of the parallax in longitude, as aſſigned in the Coroll. to Prop. I. and if the point aſſumed in the ecliptic be 90° diſtant from the moon's true place, BE will approach near enough to that parallax for the purpoſe intended.

After the ſame manner may the parallax in longitude be found for any other time aſſumed. Alſo if the arch AC be taken equal to twice the complement of the obliquity of the ecliptic, that is, BC equal to twice that obliquity, BE will be nearly equal to the parallax in latitude, provided DE be taken equal to the verſed ſine, to the like ſcale, as before, of the complement of the right aſcenſion, of the point of the ecliptic on the meridian. And thus may be found the fitteſt interval of time for the three calculations of the parallaxes, &c. I have above propoſed in general an hour; but in great eclipſes it would be beſt to aſſume this interval ſomething greater, and in ſmall eclipſes leſs.

Moreover theſe conſtructions may be performed with very little trouble, any ſmall ſector being ſufficient for the purpoſe.

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Fig 1

Fig 2

Fig 3

Fig 4

Fig 5

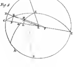

Fig 6

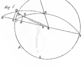

Fig 7

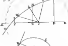

Fig 8